Report of Foundation Investigation

Proposed F.A.A. Hanger and T Building

Boeing Field, Washington

For

King County Architecture

Paul Weber & Associates
Ground Engineering
Seattle, Washington

January 28, 1977

INTRODUCTION

This report presents the results of our foundation investigation at the site of the proposed F.A.A. Hanger and T Hanger to be constructed at King County International Airport. The hanger facility is to be located immediately north of the existing F.A.A. Office Building on East Marginal Way. The general location of the site is shown with respect to existing features along East Marginal Way on Drawing No. 1.

The proposed hanger facility includes a conventional hanger building together with adjoining office space and a separate T hanger structure. Both these buildings will be located in the same area immediately north of the existing F.A.A. building. Very little is known about the design details at this time, except that the hanger facility will be approximately 90' by 110' in plan and the T hanger building will be approximately 60' by 200' in plan. It is anticipated that column loads will be moderate in the concrete tilt-up hanger building, probably on the order of fifty to one hundred kips each. Column loads in the office wing may be slightly higher depending on design details. The loading in the T hanger building will be relatively light since this is an industrial steel building. Footing loads probably will not exceed one to two kips per lineal foot.

SITE CONDITIONS

The hanger site is currently used as a parking lot, is relatively level, and is paved with asphalt concrete surfacing. Site elevations are shown on the Site Plan on Dwg. No. 1. The drainage is easterly and presently picked up by catch basins and subsurface storm drainage lines. The parking lot pavement is in good condition indicating that a well constructed and drained subgrade was provided prior to surfacing the area.

SITE GEOLOGY

The geology is rather simple at this site. Boeing field occupies the Duwamish River Valley which is a recently filled, glacially eroded valley. Drainage, primarily from the Mount Rainier area, has carried sediment into the old U-shaped glacial valley and filled it with several hundred feet of sands and silts. The river channel which carried the sediments meandered across the valley as filling proceeded producing a very wide variation in soil composition within short distances. Dispite this fact, several boring programs in the vicinity of the site reveal basically similar subsurface conditions, as will be discussed later.

Before modern times, the site was six or seven feet lower than at present and has been filled by hydraulic dredging in the period around the early 1900's.

SUBSURFACE CONDITIONS

The borings from the adjacent F.A.A. building were available at the time investigations were planned for this site, enabling us to anticipate the soil conditions fairly well. However, the existence of a former building on the site came as a surprise and was not revealed until after the field investigations were completed. This building occupied the site at a time when the site grade was two or three feet lower than the existing grade. From problems encountered in our field explorations, we estimate that the footings for this pre-existing building were six or seven feet below site grade. An outline of the approximate area containing this former building is shown on

Drawing No. 1.

The subsurface conditions were explored by drilling three borings with truck mounted, hollow-stem auger equipment, and by advancing three cone penetrometer tests. The location of each is shown on Drawing No. 1. The borings were relatively shallow and were made primarily to extract undisturbed samples of a silty layer that was suspected to be within the top twelve or thirteen feet of the site. The cone penetrometer tests were taken deeper to provide data on other compressible layers or bearing strata for the support of pile foundations. The logs of the borings are shown on Drawing Nos. 2 and 3 and the cone penetration tests on Drawing Nos. 4 thru 6.

All of the tests encountered the pavement structure and its subgrade fill which consist of about three inches of asphalt concrete pavement and eighteen to twenty-four inches of dense, sand and gravel fill. The pavement fill is underlain by an additional two or three feet of sandy fill. The sandy fill is typical of the sand found in the Duwamish river deposits.

A relatively thin silt layer was encountered between the depths of about seven feet and eleven feet in all of the exploration work. This layer is not homogeneous, but varies in structure with depth. The upper portion is fine grained and moderately compressible. The deposit grades gradually stiffer and sandier with depth until at a depth of ten or eleven feet, the samples are composed almost entirely of sand. This variation shows most direct on the cone penetrometer logs where we see a decrease in cone penetration down to a depth of about eight or nine feet and then a gradual increase in cone penetration resistance as the layer becomes sandier and less compressible. This characteristic of the silt layer is well depicted by four consolidation tests which were run on thin-walled tube samples extracted from the depth between eight and eleven feet. The results of these consolidation tests, shown on Dwg. Nos. 7 and 8, show that the deeper soils are much less compressible than the pure silt from the top of the stratum.

The silt stratum is underlain by a fairly uniform deposit of fine to medium sand, characteristic of the material of volcanic origin being transporte from the area of Mount Rainier. The sand increases rapidly in density and then remains dense to very dense for the depth of the exploration. Occasionally, the tests encountered a weaker silty sand or sandy silt lens within this deep deposit of sand, but none of these are extensive or thick enough to be of concern to building support.

The ground water table was unusually low at the time of our investigatio approximately eleven or twelve feet below site grade. This low water table is thought to be associated with the low rainfall this area has experienced this year.

FOUNDATION SUPPORT - HANGER AND OFFICE BUILDING

The important consideration in foundation support of this structure is the compressible silt layer found at a depth of about eight or nine feet below the site grade. Laboratory tests were performed on this layer to determine its compressibility. Using the values from the tests in an analysis of foundation settlement, we find that the settlement is not significant and, therefore, recommend that the building be supported on shallow spread footings.

The second major consideration in foundation design is the possibility of differential settlement across portions supported over the old foundation anc portions not supported over them. The existing foundations represent a hard spot in the subsurface which would yield very little compared to other parts of the site not underlain by concrete foundations. To alleviate this problem, we recommend that the existing soils be over-excavated at footing locations and recompacted to 95 percent of modified compaction density. The soil to be excavated will be basically granular in nature. There is some rubble and miscellaneous debris in the fill but this should not represent a significant portion of the total material excavated. This excavated material will be satisfactory for backfill and can be placed back in the pit at each footing location and compacted as described above.

We recommend that the soil be removed to a depth of four feet below the bottom of the planned footing. Footings should be placed as high as practicable to reduce the depth of excavation. We suggest that footings be placed about one foot below the existing site grade. Structural considerations may require a greater depth; the structural engineer should consider this. The over-excavation should extend in a truncated pyramid-shaped zone the same dimensions in the plan as the footing at a depth of four feet below the bottom of the footing and expanding in size on a forty-five degree slope to the ground surface The recommended action is depicted graphically on Dwg. No. 9.

Footings may be designed for an allowable soil bearing capacity of 3 kips per square foot with a 50% increase for seismic or wind loading.

Since this is a previously developed site, there could be some surprises in the subsurface based upon undisclosed manmade conditions. For instances, there may be buried storage tanks containing fuel, water or other materials. Another possibility is that localized zones within the depth of six or eight feet may contain debris, garbage, or soft soils which would have to be removed during foundation construction. Some allowance should be made in the specifications for overexcavating any random, manmade material judged unsuitable for foundation or floor slab support.

The floor slab of the structure can be built as slab-on-grade provided the top one foot of material underneath the drainage course be compacted to 95% of modified compaction density.

Settlement of individual footings is not expected to exceed three-quarters of an inch; differential settlement between adjacent columns is not expected to exceed one-half inch. Settlement will be rapid and will be at least 90% dissipated by the end of construction.

FOUNDATION SUPPORT - T HANGER

The existing pavement structure is underlain by approximately two feet of dense, competent granular material. Since the T hanger structure is lightly loaded, I recommend that footings be placed as shallow as possible in the pavement structure and designed for an allowable soil bearing pressure of 2 kips per square foot.

SEISMIC DESIGN CONSIDERATIONS

On the whole, the seismic characteristics of this site appear to be quite favorable. The dense sand found below the silt layer would be very stable under dynamic activity; dense sand is not subject to liquifaction and large strains like loose sand. The foundations would lie above the silt layer which would act as a damping and sliding base during dynamic activity. One would expect most of the strains resulting from an earthquake motion to be taken out in this thin zone of weak soil rather than in the ground immediately under and around the structure.

COMPARISON OF SUBSURFACE DATA

We have been using the cone penetrometer in alluvial soils for several years now, and are beginning to demonstrate its technical superiority to auger drilling methods when sampling below the water table. A comparison of the boring data from the adjacent F.A.A. Building and our cone penetrometer tests show two completely different interpretations of subsurface conditions. We have found this to be the case on other sites near Boeing field and other places in the Kent-Auburn-Duwamish system.

The borings at the F.A.A. building suggest that the granular soil decreases in density with depth, and in fact, becomes loose at a depth of fifty to sixty-five feet. This is evidenced by the decrease in the standard penetration resistance in the borings presented by the soils consultant at that site. On another site, across the runway and near Associated Grocers, the soils report presented data on soil at a depth of 40 feet or so with a standard penetration approaching zero blows per foot. Wherever a comparison can be made, the cone penetrometer shows very dense soil at depth, while conventional sampling suggests loose conditions, or decreasing density. The flaw is in split-spoon sampling through a hollow-stem auger below the water table.

It is our present conviction that low penetration values are the result of heave in the soil at the tip of the auger under an unbalanced hydraulic gradient. As the auger is advanced, the water level inside the hallow stem is lower than the surrounding water table. At a certain depth (usually 35 to 50 feet) the soil becomes quick at the auger tip and flows upward into the hollow stem. The soil flushed into the casing is said to have "heaved". Even if the soil only lifts a few inches, a significant reduction in density results. When the sample spoon is lowered to the tip and driven, the penetration blow count reflects a loosened state in the soil.

For this reason, we believe cone penetration testing should become a standard feature on subsurface investigations in alluvial deposits. Reliance on conventional borings can and has led to recommendations for longer piles than necessary, and indeed, for piles when spread footings would have sufficed.

Respectfully submitted,

Paul R. Weber, P.E.

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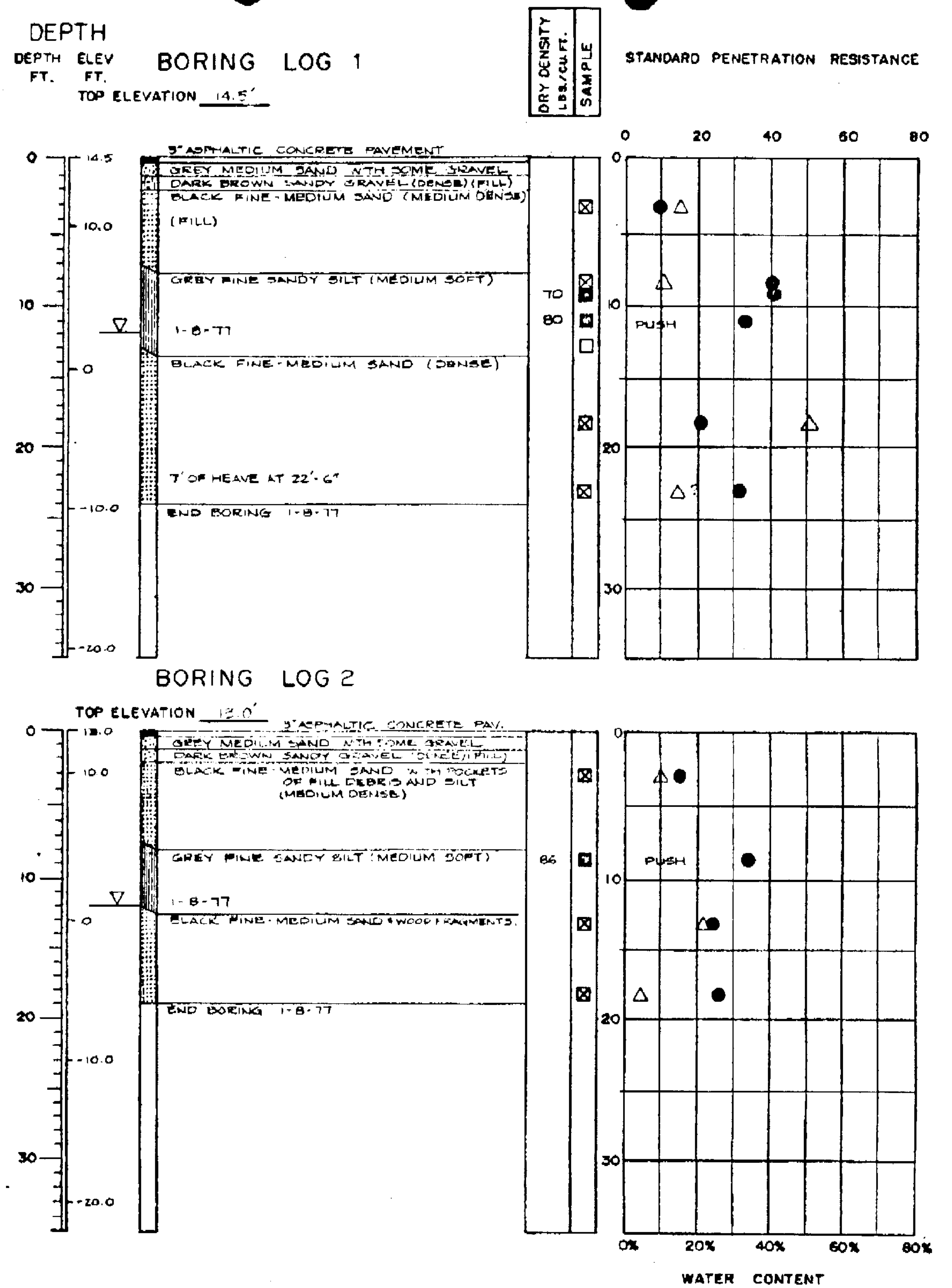
PRW:jr



LEGEND:

- ◘ UNDISTURBED SAMPLE EXTRACTED
- ⊠ DISTURBED SAMPLE EXTRACTED
- □ SAMPLE ATTEMPTED BUT LOST
- △ SPT BLOWS TO DRIVE SAMPLER 12"
- ● NATURAL WATER CONTENT
- —— PLASTIC LIMIT

FOUNDATION INVESTIGATION
KING COUNTY
FAA HANGAR / BOEING FIEL
SEATTLE, WASH.

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PAUL R. WEBER
CONSULTING SOILS ENGINEER

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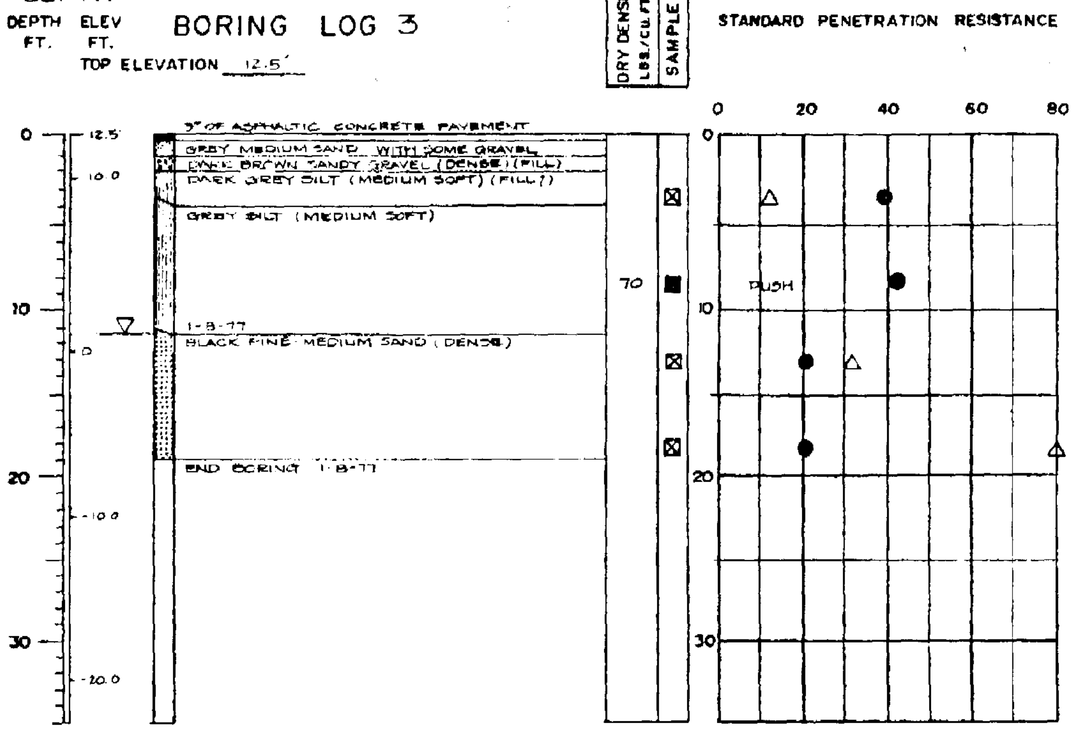

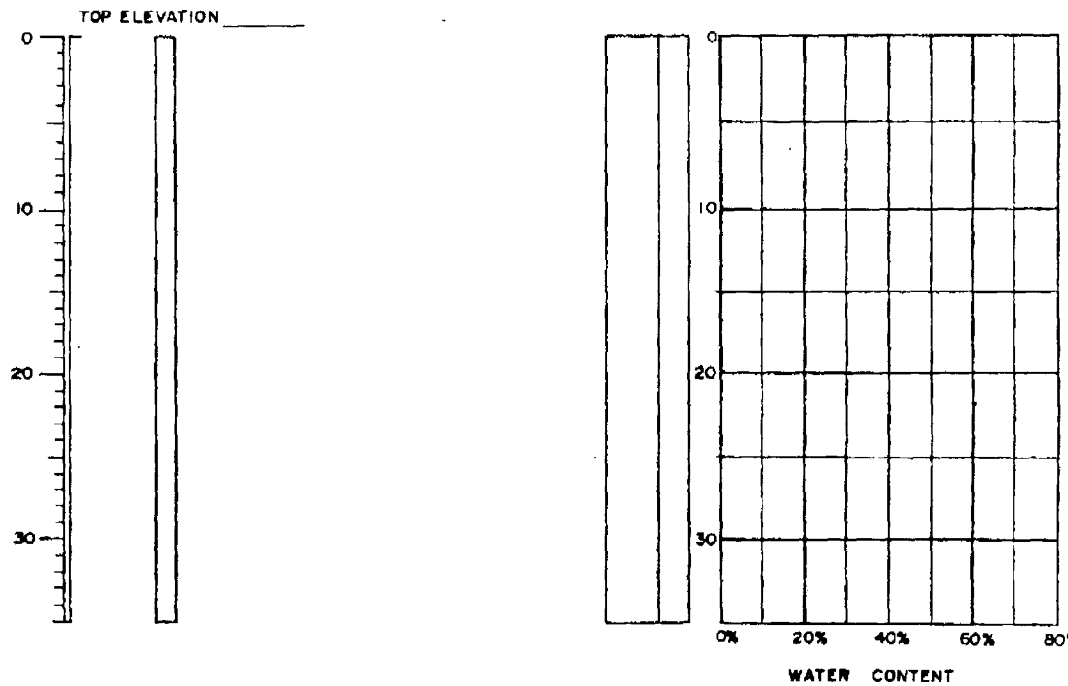

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